

## ABC of wound healing

### Burns

Alex Benson, William A Dickson, Dean E Boyce

About 250 000 people are burnt each year in the United Kingdom. Of these, almost 112 000 attend an accident and emergency department and about 210 die of their injuries. At least 250 000 others attend their general practitioner for treatment of their injury. A burn results in loss of epidermal integrity of the skin; this article discusses the aetiology and management of various types of burn injury.

## Mechanisms of burn

### Thermal injury

**Flame**—Accelerants such as petrol, lighter fluid, or natural gas are often involved. The depth of flame burn is typically full or partial thickness.

**Scald**—60% of burns in children are from scalds. Non-accidental injury is rare but should be considered if there are delays in presentation, inconsistencies in history, or an unusual pattern of injury.

**Contact**—Contact burns often present as small burns on extremities, but they can be serious in those not able to remove themselves from the source of injury, such as elderly people, children, disabled people, and those incapacitated by drugs, alcohol, fit, or faint.

**Flash**—Flash burns are usually to the face and upper limbs and are caused by an explosive ignition of a volatile substance. They are often due to use of accelerants to light a fire or gas explosions.

### Electrical injury

**Low voltage**—The energy imparted from 240 V usually gives a deep burn in the form of a small entry and exit wound. Such burns are commonly seen on the hands. If alternating current crosses the myocardium, arrhythmias may arise. If the electrocardiogram is normal and there is no history of loss of consciousness, admission to hospital for cardiac monitoring is not required.

**High voltage**—High tension burns occur with an injury resulting from 1000 V or more. These catastrophic injuries result in extensive tissue damage. Rhabdomyolysis and renal failure may occur.

**Flash**—An arc of high tension current from a high voltage power source may cause injury, without the current traversing the body. Heat can damage exposed skin, and clothing may ignite.

### Chemical injury

**Acids**—Acids cause coagulative necrosis, denature proteins, and are usually painful. Hydrofluoric acid penetrates tissues deeply and can cause fatal systemic toxicity even in small burns. Immediate copious lavage and treatment with topical calcium gluconate gel is essential. Systemic calcium may be required as hydrofluoric acid sequesters calcium with the burn.

**Alkalis**—Common household alkalis such as bleaches, cleaning agents, and cement give a liquefactive necrosis. They have the potential to penetrate tissues deeper than most acids as further injury occurs as cells dehydrate and collagen and protein are denatured. Often the onset of pain is delayed, thus postponing first aid and allowing more tissue damage.

This is the seventh in a series of 12 articles

### Aetiology of burn injuries (percentage)

#### Adults

- Flame (48)
- Scalds\* (33)
- Contact (8)
- Electrical (5)
- Chemical (3)
- Friction (2)
- Sunburn (1)

#### Paediatric

- Scalds (60)
- Flame (25)
- Contact (10)
- Electrical (2)
- Chemical (2)
- Sunburn (1)

Adapted from UK manual for "Emergency Management of Severe Burns" course. See "protocol" box next page  
\*Oil and water.



Clockwise from top left: Full thickness flame burn to the right arm, torso, and face and neck (not shown); "pull over" scald (hot tea) to a toddler; flash burn and erythema to face (note sparing of skin creases); full thickness contact burn (patient was alcoholic and fell unconscious against a portable heater)



Low voltage (240 V) electrical burns to the finger pulps



Left: Cement burns to the dorsum of the toe. These burns may initially be deemed superficial; persistence of the alkali within the skin can cause a progressive full thickness burn. Right: Full thickness caustic soda burn

## Burn assessment

The severity of burn injuries is related to the depth of skin involvement and the percentage of total body surface area involved.

In the United Kingdom burns are classified as partial thickness or full thickness, as these terms correspond to the level of burn injury and the likelihood of healing without surgical intervention.

Partial thickness burns are further categorised as superficial or deep dermal. Superficial burns usually heal without surgery, but deeper burns are likely to require excision and skin grafts. Burn depth can progress without adequate first aid and treatment such as appropriate fluid resuscitation and dressings. Burn depth can be worsened by the presence of infection. Superadded infection may lead to an increase in burn depth.

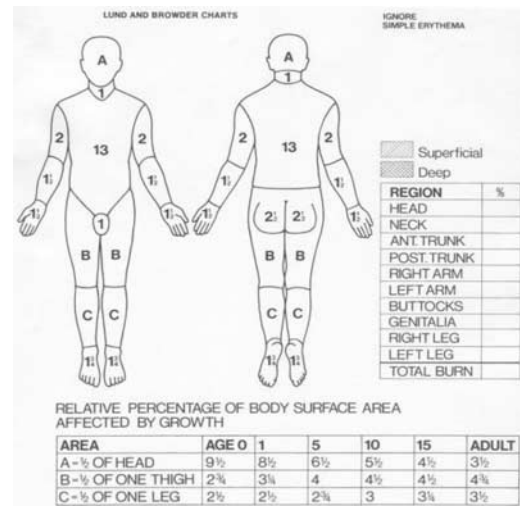
## Classification of burn depth

### Superficial burns

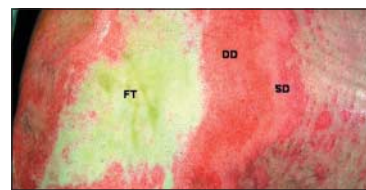
These usually heal within 14 days and leave minimal scarring. Burn erythema may be described as skin redness and pain. Erythema is not included in the assessment of the percentage of total body surface area. With superficial dermal burns the outer part of the dermis is injured; these burns characteristically have blisters and are very painful.

### Deep burns

These take a prolonged time to heal and do so with severe scarring. All but the smallest areas of full thickness burn require surgical intervention. In deep dermal burns the skin has fixed capillary staining and has blotchy cherry red appearance. It does not blanch with pressure and is typically insensate. Full thickness burns have a leathery white or charred black appearance (eschar). In people with dark skin, parameters other than skin colour may need to be used.



A Lund and Browder chart is useful in assessing the extent of burn injury (the relative proportions of body areas differ in children)



Top: Superficial dermal scald (top). Bottom: Burn injury of different depths (FT= full thickness; DD = deep dermal; SD = superficial dermal)

### Indicators of depth of burn injury

Burn type	Skin colour	Blisters	Capillary refill	Sensation	Pinprick	Healing
Epidermal	Red	Absent	Brisk	Painful	Bleeds	Yes
Superficial dermal	Pale pink	Present (small)	Brisk	Painful	Bleeds	Yes
Mid-dermal	Dark pink	Present	Slow	May be painful	Bleeds	Usually
Deep dermal	Dry blotchy red	May be present	Absent	No pain	No bleeding	No
Full thickness	Dry white/black	Absent	Absent	No pain	No bleeding	No

## Management of burn injuries

### First aid

The person should be removed from the burning source without endangering the rescuers. If clothing is alight, follow the "drop and roll" procedure. When electricity is involved, power should be turned off before administering first aid.

The burn should be cooled (or the toxin diluted) with lukewarm running water for at least 20 minutes. This period should be increased in those with chemical injury. Ice or very cold water should be avoided, as blood flow to the affected area will be reduced, and hypothermia induced, particularly in infants and elderly people.

Patients are assessed and their treatment priorities established on the basis of the severity of their injuries. The history of events leading to the burn will also alert those treating the patient to the risks of coexisting injury. Inhalation injury is potentially life threatening when burns have been sustained in enclosed areas.

**The "drop and roll" procedure: get the person to drop to the ground then help them to roll over to extinguish the flames from burning clothing (the use of a wet blanket may help)**

### Protocol for managing burn injuries\*

- A = Airway and cervical spine control
- B = Breathing and ventilation
- C = Circulation and haemorrhage control
- D = Disability
- E = Exposure and environmental control
- F = Fluid resuscitation

\*According to guidelines advocated in the course "Emergency Management of Severe Burns," run by the British Burn Association ([www.britishburnassociation.co.uk](http://www.britishburnassociation.co.uk))

Simple analgesia or opiates should be used. Covering the burn and cooling with water will also provide some pain relief.

### Dressings

Polyvinyl chloride sheeting ("clingfilm") or sterile cotton sheeting may be used initially. These are simple to use and allow wound inspection so that definitive assessment can be performed. Sterile burn cooling gels are also available.

### Minor burn injury

#### Debridement

Burn debris should be removed with mild soap and water, sterile saline, or a topical antiseptic solution before dressings are applied. The dead skin of open blisters should be removed, and large or friable blisters should also be "deroofed" (the outer layer removed). Small blisters may be left intact. Antibiotics are not routinely prescribed in minor burns. The tetanus status of the patient should be checked.

#### Dressings

In the simple, clean, partial thickness burn, dressings such as paraffin gauze (for example, Jelonet), chlorhexidine impregnated gauze (Bactigras), or similar dressings such as soft silicone (Mepitel) or soft polymer (Urgotul) can be used with an overlying gauze pad. Hydrocolloid dressings are particularly good for use on hands and other small areas of superficial or partial thickness burns, although they leave a "skim" of exudate that needs to be removed to allow appropriate assessment of the wound. In bigger burns, several layers of dressing are usually required to absorb exudate and to prevent shear or friction of the skin.

Dressings such as alginate adhere to the wound and should be reviewed after 24 hours. At this point only the secondary dressing immediately overlying the alginate needs to be replaced. Once the wound is healed, the alginate separates off. If there is excessive exudate or a full thickness burn, the dressing fails to stick, indicating the necessity for further assessment. These properties also make alginate dressings useful for donor sites after skin graft harvest.

### Major burn injury

A major burn should be managed according to the guidelines advocated in the British Burn Association's Emergency Management of Severe Burns course. Transfer of these patients needs careful planning and communication with the burns team. In a patient with multiple injuries, the most obvious injury may be their burn, but careful assessment and treatment of other injuries is vital before burn management. All patients with facial burns or suspected of having inhaled smoke or hot gases should be assessed by an anaesthetist before being transferred to a specialist unit, as early intubation may be required.

Deep or full thickness burns make the skin inelastic and act like a tourniquet. They should be released by escharotomy to prevent respiratory embarrassment (of the chest and abdomen) or vascular compromise of the limbs. This may need to be done before transfer to a specialist unit.

Fluid resuscitation is indicated after a serious burn ( $\geq 10\%$  of total body surface area in children and  $\geq 15\%$  in adults). The British Burn Association recommends the use of the Parkland formula, but intravenous fluids should also be guided by the patient's response to resuscitation.

Surgical debridement of the major burn is influenced by the fitness of the patient to undergo a procedure and the depth and location of the burn. Excision of the burn may be required. Reconstruction is often done with split skin grafts taken from the patient in single or multiple stages. This may be combined

**All burns are susceptible to infection. Silver based products have traditionally been used to treat burns, including silver sulfadiazine (Flamazine) and silver sulfadiazine plus cerous nitrate (Flammacerium)—the latter available only on a named patient basis in the UK. However, the use of these preparations makes subsequent assessment difficult. Ideally, they should not be applied without discussion with the burns team**

### Criteria for referral to a burns centre

- Associated airway injury
- Partial thickness burns  $< 5\%$  of total body surface area in a child
- Partial thickness burns  $< 10\%$  of total body surface area in an adult
- $< 1\%$  full thickness burn
- Partial or full thickness burns to face, perineum, external genitalia, feet and hands, and over joints
- Circumferential injury
- Chemical and electrical burns
- Extremes of age
- Non-accidental injury
- Comorbidity
- Non-healed burn three weeks after injury

**Repeated review of the burn wound and multiple dressing changes are unnecessary. A change of dressings and wound review after 48 hours is usual. Further changes are guided by the rate of healing, but are generally needed at intervals of two to three days. More frequent change of dressing is needed if there is a high volume of exudate or evidence of infection**



Escharotomies to the chest to allow respiratory expansion

### Fluid resuscitation guide based on Parkland formula

Calculations are guidelines only and refer to fluid required from the time of burn injury, not the time of presentation. Volumes refer to fluid resuscitation for the first 24 hours: half is given in the first 8 hours, and half over the subsequent 16 hours

#### Resuscitation formula for adults

- 3-4 ml Hartmann's solution/kg body weight/% total body surface area

#### Resuscitation formula for children

- 3-4 ml Hartmann's solution/kg body weight/% total body surface area, plus maintenance fluids (4% glucose in 0.25N saline or 0.2N saline)



with cadaveric skin if the patient has insufficient donor skin. Artificial skin substitutes are being increasingly used with good results (see a later article in this series). Several layers of dressings are used to minimise shear at the site of skin grafting. These should not be too tight as swelling often occurs after a burn injury.

Once a burn has healed, the area should be regularly moisturised and protected from the sun by sunblock cream or clothing. Physiotherapy may be required to prevent burn contractures.

#### Further reading and resources

- Herndon D. *Total burn care*. 2nd ed. London: Saunders, 2002.
- National Burn Care Review. National burn injury referral guidelines. In: *Standards and strategy for burn care*. London: NBCR, 2001:68-9.
- Burnsurgery.org (a website designed to be a comprehensive educational tool for burn care professionals worldwide) [www.burnsurgery.org](http://www.burnsurgery.org)

Alex Benson is specialist registrar in plastic surgery in the Mersey Regional Plastic Surgery Unit, Whiston Hospital, Liverpool. William A Dickson is consultant burns and plastic surgeon and Dean E Boyce is consultant hand and plastic surgeon in the Welsh Centre for Burns and Plastic Surgery, Morriston Hospital, Swansea.

The ABC of wound healing is edited by Joseph E Grey ([joseph.grey@cardiffandvale.wales.nhs.uk](mailto:joseph.grey@cardiffandvale.wales.nhs.uk)), consultant physician, University Hospital of Wales, Cardiff and Vale NHS Trust, Cardiff, and honorary consultant in wound healing at the Wound Healing Research Unit, Cardiff University, and by Keith G Harding, director of the Wound Healing Research Unit, Cardiff University, and professor of rehabilitation medicine (wound healing) at Cardiff and Vale NHS Trust. The series will be published as a book in summer 2006.



Top: Full thickness burns of the abdomen have been excised and closed with split thickness skin grafts. Bottom: Artificial skin substitute used to cover full thickness burn

**Prevention of burns is key: the main improvement in reduction of burns in the UK over the past 40 years has been the introduction of legislation to reduce the flammability of clothing, furniture, and fireworks and of proper labelling of inflammable materials**

Competing interests: For series editors' competing interests, see the first article in this series.

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## The Napsterisation of learning

At *BMJ Learning*, we like to think that we are creating something new—an evidence based, interactive, and interdisciplinary learning service. But sometimes I wonder how different it is from what has gone before. In the past, learning was about teachers giving information from the lectern to the grateful recipients below. We like to think that we are interactive and that we engage learners rather than lecturing them. But critics of *BMJ Learning* would say that it is still a large compendium of learning resources that learners must work their way through. Certainly the internet enables us to communicate large amounts of new and easily updated knowledge quickly and easily—but that is just using a small part of its potential.

In 2000, just as dot com was turning into dot bomb, Shawn Fanning founded Napster—a system whereby internet users could share music files. It is an idea that is now changing the face of the internet. There is no large behemoth bestowing resources or wisdom from on high—rather it is about putting people in touch with each other. How can this help with learning? Well, no learning resource, no matter how big, can answer all possible questions. Our recent module on hepatitis B gives an overview on recent advances on how best to treat patients with this infection. But what if you are caring for a patient with hepatitis B who also has hepatitis C and who is intolerant of interferon and who doesn't like taking drugs anyway? Our learning module won't be able to answer such a specific question, and it is likely that no learning resource will be able to do so. So what do you do? You

could ask your colleagues down the hall, but what if they don't know either?

Another option is to go online and ask a colleague. The new discussion forum that we have added to [www.bmjlearning.com](http://www.bmjlearning.com) enables you to do exactly that. Like the Napster model, it is a peer to peer system that puts end users in touch with each other. Learners and teachers have always shared with each other—lecture notes, presentations, quotes, etc—and a learning forum enables you to do just that, but with thousands of potential colleagues rather than just one. You will also get the question that is important to you answered—rather than the question that is important to the author.

Critics of peer to peer systems say that they can result in chaos and that you cannot guarantee that the answer to your question is correct. But, as Donald Clarke of EPIC says, “regular internet users accept the trade-off between chaos and usefulness.”<sup>1</sup> In addition, we moderate our forum to ensure that the postings are of high quality and that users respect patient confidentiality. Also a form of natural selection ensures that the best postings are the ones that everyone sees while the poor ones gradually fade from view. As the peer to peer gurus say, we now have “connection as well as collection.”<sup>1</sup>

Kieran Walsh *clinical editor, BMJ Learning*  
([bmjlearning@bmjgroup.com](mailto:bmjlearning@bmjgroup.com))

- 1 Clark D. White paper: Napsterisation of e-learning (P2P). [www.epic.co.uk/content/resources/white\\_papers/p2p.htm](http://www.epic.co.uk/content/resources/white_papers/p2p.htm) (accessed 6 Dec 2005).